

Unraveling some Kinki worms (Annelida: Oligochaeta: Megadrili: Moniligastridae) - Part I

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Abstract. A new species, *Drawida eda* Blakemore, is proposed for an earthworm from rice paddy near Lake Biwa in central Japan. It is compared with both *Drawida barwelli* (Beddard, 1886) – the cosmopolitan type of the genus – and with sympatric *D. japonica* (Michaelsen, 1892) for which a new synonym, *D. propatula* Gates, 1935, is added. Parasitic origin theory of diagnostic ‘genital markings’ in *D. japonica* is extended to other taxa and their conspecificity is mooted. Definitive resolution of the taxonomic complexities within *Drawida* via DNA analysis is pending, although the COI barcode for the type of *D. eda* is initially provided, the first time for a new earthworm species. Polygicerate similarity of Oriental ‘exquisiticlitellate’ *Drawida* to megascolecid genera like *Nexogaster* Blakemore, 1997 (type *Nexogaster sexies* Blakemore, 1997) is briefly noted. Using this opportunity, replacement names are given for two preoccupied Tasmanian Lake Pedder taxa as a normal part of taxonomic ‘housekeeping’, viz. *Anisogogaster* for *Anisogaster* Blakemore, 2000 (non Deyrolle, 1862, nec Looss, 1901) and *Perionchella variegogata* for *Perionchella variegata* Blakemore, 2000 (non Michaelsen, 1907).

INTRODUCTION

Taxonomy of the large Indo-Oriental family Moniligastridae is beset by many small and apparently similar-looking taxa. Moreover, several key features are often ambiguous. New consideration of possible parasitic origin of characteristic yet highly variable ‘genital markings’ is an additional complication (see Blakemore *et al.* 2010 and *vide infra*).

In Japan, moniligastrid taxonomy is no less confused than for its other megadrile groups, thus the first and only comprehensive review by Easton (1981: 37, tab. 1) stated: “*None of the eight [Drawida] species considered here is particularly well known and the specific status of each requires closer investigation*”. In fact, only two of the eight have been encountered since their contrivance by other than their original authors,

viz. *Drawida hattamimizu* Hatai, 1930, which was dealt with by Blakemore *et al.* (2010), and *D. japonica* (Michaelsen, 1892) – the extent of which is reconsidered based upon historical types and recently re-surveyed material.

As with other taxonomic problems, a possible solution to *Drawida* quandaries is to employ DNA barcoding, for example using the mtDNA COI marker, and ideally this will initially be from primary types. The current paper aims to investigate taxonomic resolution via DNA extraction in compliance with ICZN (1999) Principle of Typification. Types are mostly unknown for earlier Japanese described taxa and most Japanese *Drawida* species are omitted completely from the register of Reynolds and Cook (1976). Reference barcoding of types in Japan, as with other regions, has the following contingency outcomes:

Contingency chart of molecular barcoding from primary types of a species (Sp)

Morphological Sp	Types	Sample DNA	Molecular Result
Known (valid name)	Present (old?)	Holotype/Lectotype (from Syntypes)/Hapanotype, etc.	Confirm species and/or synonymy
Known (valid name)	Absent or lost	Neotype (preferably from amongst topotypes)	Confirm a ‘good’ species or ‘kidnap’ and/or sink a poor one
New and valid name	New	Holotype (Paratype)	Compare taxa/morphs

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Multiple intestinal gizzards in series that characterize *Drawida* occur in some Eudrilidae (e.g., *Hyperiodrilus* Beddard, 1890) and are also remarkably prevalent analogs convergently evolved in Tasmanian megascolecids, particularly those from the Lake Pedder area of the Western Tasmanian Wilderness, perhaps relating to a mutual tendency to geophagy. Whereas *Provescus* and *Hypolimnus*, both described by Blakemore (2000), have doubled or multiple oesophageal gizzards, exemplars of multiple intestinal gizzards are: *Nexogaster* Blakemore, 1997 (type *Nexogaster sexies* Blakemore, 1997), *Retrovescus* Blakemore, 1998 (type *Retrovescus plomleyi* Blakemore, 1998), *Tassiedrilus* Blakemore, 2000 (type *Tassiedrilus griffithae* Blakemore, 2000), *Gastrodrilus* Blakemore, 2000 (type *Gastrodrilus driesseni* Blakemore, 2000), and *Anisogaster* (type *Anisogaster quini* Blakemore, 2000).

This latter genus is a homonym [non *Anisogaster* Deyrolle, 1862 (Coleoptera) nec Looss, 1910 (Trematoda)]. Tasmanian *Perionychella variegata* Blakemore, 2000 is also a junior homonym of Himalayan *Perionychella variegata* Michaelsen, 1907 that is now, at least following Stephenson (1923, 1930), held as *Perionyx variegatus* (Michaelsen, 1907). The opportunity is taken herein to provide replacement names to these two preoccupied taxa as required under the rules of ICZN (1999) and as a part of routine taxonomic ‘house-keeping’.

MATERIALS AND METHODS

Classification follows the convention and methodology style of Blakemore (2000, 2008) that allows for organic variability in natural members of a taxonomic entity.

DNA extraction, amplification and sequencing methodology follows that given in Blakemore *et al.* (2010), and these new data as presented in an Appendix will be submitted simultaneously to the GenBank online facility [<http://www.ncbi.nlm.nih.gov/genbank/>].

RESULTS

Systematics Results

The preoccupied genus name *Anisogaster* Blakemore, 2000 [non *Anisogaster* Deyrolle, 1862 (Coleoptera), nec Looss, 1901 (Trematoda)] is herein replaced by *Anisogogaster* Blakemore **nom. nov.** [etymology: genus name with “-go-” added for euphony yet, as stated by ICZN (1999: Art. 30.1.2.): a genus name ending in *-gaster* should be treated as Latinized feminine]. The preoccupied species name *Perionychella variegata* Blakemore, 2000 [non *Perionychella variegata* Michaelsen, 1907b: 158] is here replaced with *Perionychella variegogata* Blakemore **nom. nov.** (etymology: noun in apposition with “-go-” added for euphony and to remove homonymy as required by ICZN (1999: Arts. 23.3.5, 23.9.5, 31.2.1, 39, 52, 53.3 and 60)).

Genus *Drawida* Michaelsen, 1900: 114 as per Stephenson (1923, 1930) and as recently redefined in Blakemore *et al.* (2010).

Type species. *Moniligaster barwelli* Beddard, 1886: 94, figs. 4-6 by original designation.

Type locality. Manila, Luzon, P.I.; types in British Museum (BMNH 1904:10:5:522-3 according to Reynolds & Cook, 1976) were disputed by Easton (1984: 112) who stated: “examination of the specimen (BMNH: 1904:10.5.2-3) [sic], and the associated slide of the body wall, produced no useful data. The specimen is a posterior fragment about 66 mm long. As this is considerably larger than the dimensions provided by Beddard, it is doubtful whether this individual belongs to the type series.”

Easton then redescribed *Drawida barwelli* on new material from the Pacific Isles and from Jamaica. It is nevertheless possible that the type series retains extractable DNA, and this will be investigated in a later publication.

Species descriptions

Drawida barwelli (Beddard, 1886)

(Figs 1.1-1.4)

Moniligaster barwelli Beddard, 1886: 94, figs. 4-6.

Drawida barwelli: Blakemore 2002: 69, 2008: 119 (for complete synonymy).

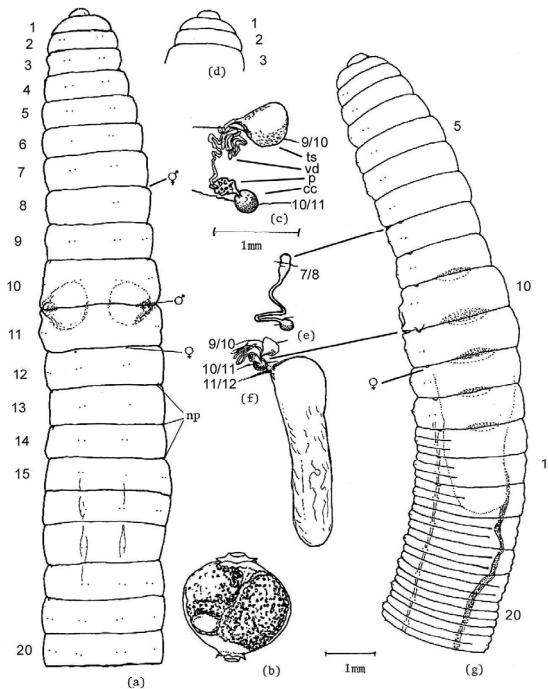


Figure 1.1. *Drawida barwelli*, ex Samford (Qld, Australia) specimens anaesthetized in alcohol, sketched then dissected: a = ventral view, b = cocoon, c = enlargement of testis sac on septum with convoluted vas deferens to 'prostate' on copulatory chamber, d = dorsal view of prostomium, e = spermatheca and f = male organs and distended, gravid egg sac shown in relative position, g = lateral view (dorsal blood vessel and eggs sac visible through cuticle)

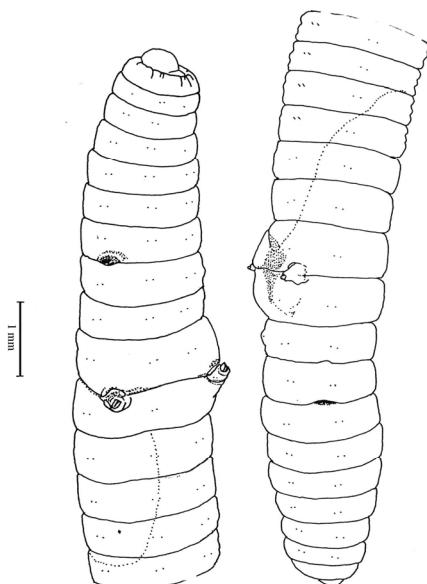


Figure 1.2. *D. barwelli*, two amphimictic Samford specimens captured 'in flagrante delicto'

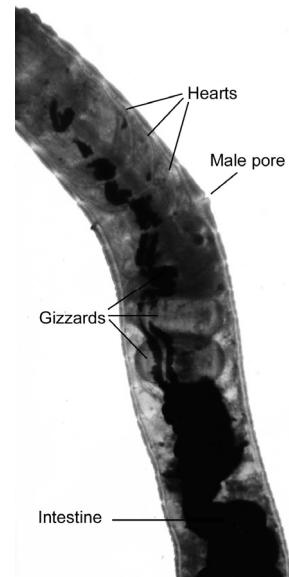


Figure 1.3. *D. barwelli*, live specimen gently compressed under glass slides (photo by RJB)

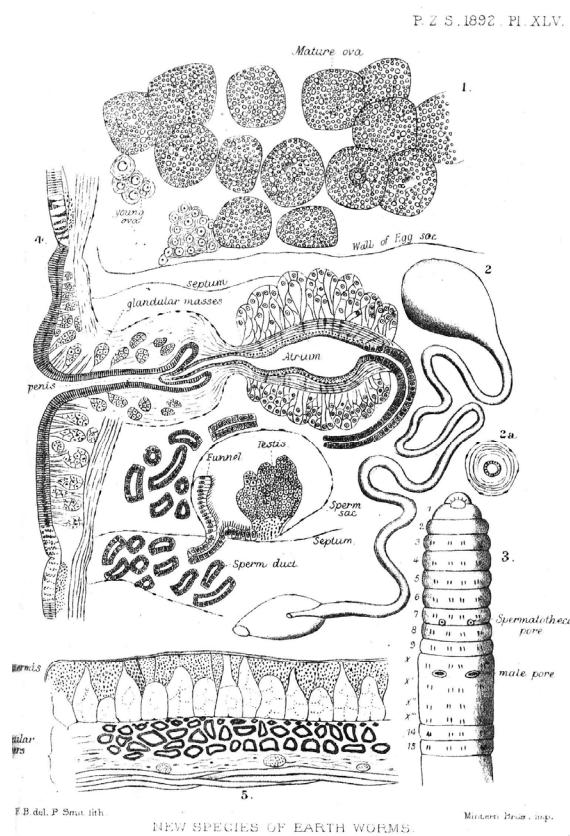


Figure 1.4. *Drawida barwelli* synonym *D. bahamensis* after Beddard (1893, Pl. XLV)

Material examined. *Drawida barwelli* types in British Museum (BMNH 1904:10:5:522-3) were disputed by Easton (1984: 112) who re-described the species from new material after finding that the type series, which he labeled “(BMNH: 1904:10. 5.2-3)”, comprised a posterior portion and an associated slide that produced no useful data (although DNA is possibly retained?); Australian material: Canberra ANIC: RB.95.4.1, numerous specimens collected at Samford, Qld (27°22'S, 152°53'E) by RJB in 1992 (Blakemore 1994).

Remarks. Description is restricted to figures and comparative Tables 2 and 3 below. *Drawida barwelli* is fully described, figured, photographed, and its synonymy, world distribution and historical records accounted for in Blakemore (1994, 1999, 2002, 2008) with this species as the first record of a moniligastrid from Australasia, and of *D. barwelli* from Thailand (as *D. beddardi* synonym) and Hainan, China for *D. gabella* Chen, 1938 **syn. nov.** Specimens of similarly small and unpigmented species may be easily confused superficially, not least *D. japonica* and *D. eda* as described next.

***Drawida eda* Blakemore sp. nov.**

(Fig. 2)

Type material. Rice paddy survey, Tanakami region nr. Kurotsu, southern Otsu-shi, Shiga-ken, Kinki, Japan - ca. 35°1'N, 135°51'E, elev. ~80 m, 17.VI.2009 sample stations #4-6, leg. RJB, all deposited with initial Accession No.: Misc. Invert. FY2009-13 in Lake Biwa Museum (hereafter, LBM), Kusatsu-shi, Shiga-ken. *Holotype* (H) ex sample #6 from Eda 1-chōme (type locality), Otsu-shi, slightly larger of two mature specimens that are now separated off, sketched and dissected dorsally with a small tissue sample taken from posterior region for DNA diagnosis. Holotype Reg. No. LBM1380000097. *Paratypes* (P1) ex sample #5 with same collection data except from Inazu 4-chōme, Otsu-shi, mature, initially labelled as “*Drawida* cf. *barwelli*”, dissected, LBM 1380000101; (P2) the slightly smaller specimen with same data as H, undissected, LBM 1380000100; (P3-7) five specimens ex sample #4

with same collection data but from Kurotsu 5-chōme, Otsu-shi, inspected but undissected, LBM 1380000102.

Etymology. The specific name “*eda*” is a noun in apposition meaning “branch” in Japanese referring to type locality and alluding to phylogenetic branching off of species throughout the Darwinian Tree-of-Life.

Diagnosis. Small, unpigmented *Drawida* lacking genital markings, with male pores in 10/11 on tips of ‘comma-shaped’ eversible organs (penes) and spermathecae median of c lines in 7/8. Spermathecal atria are elongate and accompanied ventrally by a small, distinctive accessory gland. Prostates are glandular overlaying male atrium. Gizzards number five in 13–17 (but first one may be weaker). Apparent feature on preservation is male organ extrusion only from 10/11 lvs (from the observer’s point of view), seen consistently in all specimens that is probably a product of preservation.

Distribution. Known only from the type locality which is not unusual for such small species that are often overlooked or mistaken for other taxa, e.g. *D. barwelli* or *D. japonica*. Its restricted distribution may also be indicative of an exotic introduction.

External features. Holotype and paratypes all appear mature although clitella are not particularly distinct. Biometry: lengths (mm) range 40–86; H 86, P1 66+ (posterior amputee regenerate), P2 85, P3 50, P4–6 40, P7 40+ (posterior regenerate); width about 2 mm. Segments: H 154, P1 116 with the last 16 regenerated. Body circular but slightly quadrangular in posterior section. Unpigmented/pale in ethanol. Prostomium prolobous. Dorsal pores absent although thinning and imperforate dark spots seen in some specimens. Setae lumbricine with ratio figured for segment 12. Clitellum in ½9–13 or less for H. Nephropores seen on clitellar segments approximately in d lines, but closer to c lines further posteriorly. Spermathecal pores in 7/8 in cd but just closer to c lines, quite deep with possibly minute pore

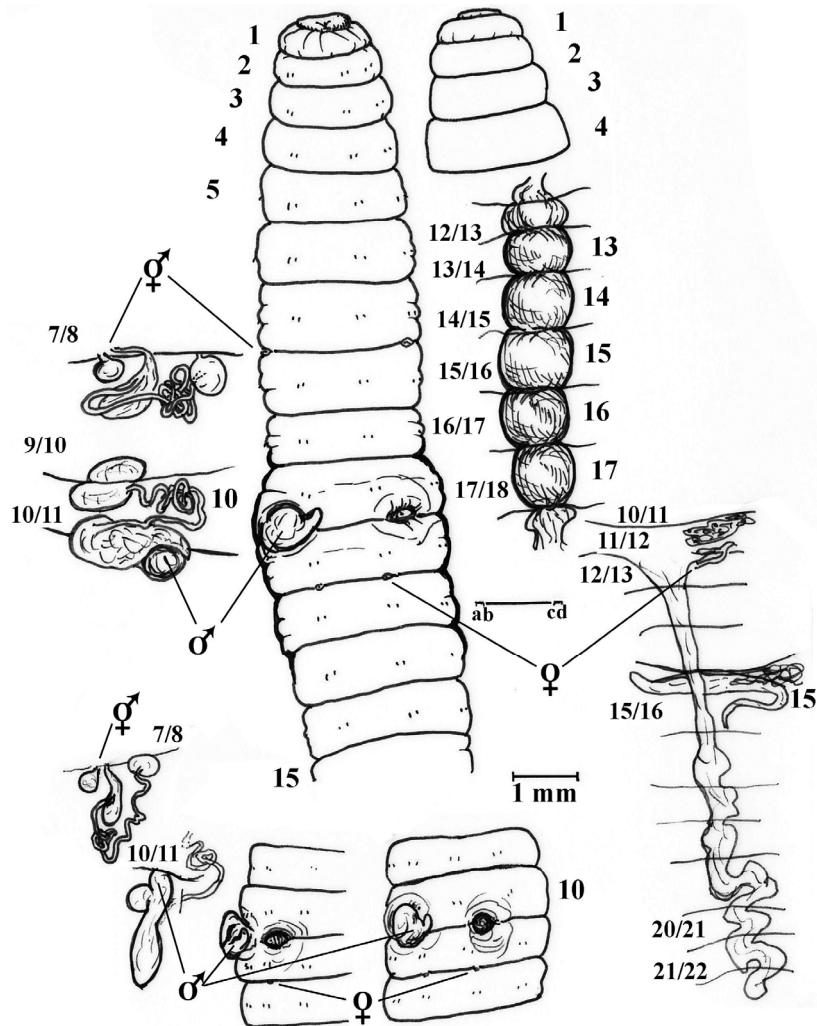


Figure 2. *Drawida eda* Holotype and P1 showing ventral view of H with its spermathecal, male and female organs marked as they appear *in situ*; its gizzards in the region of 13–17 and a single nephridium for shown example in segment 15; genital region of P1 in ventral and ventro-lateral view with similar arrangement of genital organs – see text for details

adjacent to spermathecal opening intramurally. Male pores in all specimens have lhs male pore extruded and appearing as inward-facing flat comma-shape with primary pore median-most on comma's tail; the rhs pore is invaginated and wide just lateral to *b* lines, sometimes with only the penial tip extruding. Female pores minute in 11/12 in *ab* slightly closer to *b* lines.

Internal anatomy. Septa converged around ovarian segment as usual. Nephridia holoic with large sausage-shaped bladders seen from 6 (at

least) and retained in segment 10. Hearts in 6–9 and dorsal blood vessel single. Spermathecal ampulla attached to posterior face of septum 7/8 with long, convoluted duct to wall of large thumb-shaped atrium (apparently entering about mid-length). Adjacent on the outboard side to where the narrowing atrium exits is a small sessile but solid accessory gland (seen in both dissected specimens). Testes in sacs that transgress septum 9/10 with elongate and convoluted vas deferens appearing to enter apex of large elongate and glandular prostate that is S-shaped overlaying

spherical male chamber (male atrium) in 10/11. Ovaries are large on posterior face of septum 10/11 with oviducts opposite and lateral to ovisac entrances from septum 11/12 that extend back through to 21/22 in H or to just 13/15 in P1. Oesophagus widens in 12 and gizzards are muscular spheres in 13–17 (five of in H and P1) but perhaps weaker in 13; intestine proper commences behind gizzards in 18.

Ingesta. Not noted but assumed to be geophagous based on the muddy habitat.

Behaviour. Apart from the extrusion of the lhs male pores on preservation, no ethological characters were recorded.

Genetics. A small tissue sample was taken from non-essential posterior segments of H for DNA extraction and sequencing to provide COI barcode (data in supporting online material).

Parasites and predators. None noted.

Ecology. Nothing is yet known of its ecology except that it appears to survive in cultivated and/or waterlogged paddy soils. Other species found on the same collecting trip with H and P2 in sample #6 were *Amynthas corticis* (Kinberg, 1867) and from other samples #4–5 were several pheritimoid megascolecids plus the ocnerodrilid *Eukerria saltensis* (Beddard, 1895) and several lumbriids (see Part II accompanying paper).

Remarks. *Drawida eda* is similar in superficial appearance and biometry to *D. barwelli* and to specimens of *D. japonica* that lack markings. Features that distinguish these entities are the eversible male pore structures in *D. eda* that are developed rather more than simple penes or mounds, and the gizzards that are more numerous and posteriorly placed being five in 13–17 in *D. eda* (Tables 2, 3). Nephridial details may also differ. Accessory glands outboard of each spermathecal atrium appears distinctive in *D. eda* although a similar feature occurs in *Drawida nemora* Kobayashi, 1936, *D. keikiensis* Kobayashi, 1938, *D. tairaensis* Ohfuchi, 1938 and *D. jeholensis* Kobayashi, 1940. These may thus be the nearest taxa, however they all have fewer gizzards (Table

3). *Drawida nemora*, as redescribed by Kobayashi (1938, 1940), has three to five gizzards in some of 12–16; *D. keikiensis* has gizzards in only 12, 13–15; *D. tairaensis* has four from 13 (i.e., in 13–16?). Chinese *Drawida jeholensis* has two or three gizzards in 11, 12–13. In some of these species a further difference is irregular genital markings (when present!).

The key in Michaelsen (1900: 114) points the current specimens to Indian and Aru Island *D. parva* (Bourne, 1894) *sp. dub.* that differs not least by fewer gizzards in 14–16, 17.

An interesting feature of the Lake Biwa worms is that specimens had the lhs male apparatus everted consistently, whereas the rhs organ was either invaginate or only the tip of the penis was visible. This is similar to one specimen from the Juan Fernandez Isles described as *D. bahamensis* (Beddard, 1892) by Gates (1969) with only their rhs male pores extruded, this taxon is now in synonymy of *D. barwelli*, nevertheless it may be a characteristic of worms within this species group.

The mtDNA-COI barcode should help to definitively differentiate *D. eda* from any sympatric or exotic congeners (data in Appendix). Morphological comparison with *Drawida barwelli* is touched on above; *D. japonica* is described and compared next below.

Drawida japonica japonica (Michaelsen, 1892)

(Figs 3.1–3.7)

Moniligaster japonicus Michaelsen, 1892: 232–233. [From Japan. Syntype in Hamburg Museum: 403 (Reynolds & Cook 1976), but originally stated by Michaelsen as in Zoological Museum, Berlin: Verm. 2122 and this syntype is also listed by Hartwich & Kilias (1989: 268 as “Japan; HILGENDORF leg.” just after *Allolobophora japonica* (Verm. 2117). Both were collected by Herr Dr Franz Hilgendorf, the latter definitely at Enoshima on 29.III. 1875 – thus this is possibly a type locality of the *D. japonica* syntype although my searches of the island have thus far proved fruitless for this species. Gates (1939: 411–413) did not mention #403 but he inspected three specimens from Hamburg labeled “V 1194. *Drawida japonicus* Mich. f. Typ. Dr Chen F. Wu c. Dr Michaelsen a. Nanking, China” and other materials none of which were types, saying (incorrectly) on page 413 that the original two types – described by Michaelsen as “Diese

Art ist durch ein geschlechtstreifes und ein unreifes Exemplar vertreten – were sectioned and are no longer available for study. Note the “*Typ.*” in the China label refers to *D. japonicus f. TYPica* not to a true type specimen].

[?*Moniligaster bahamensis* Beddard, 1893: 690, figs 1-5.; Beddard 1895: 202. Type locality Kew Gardens imported with plants from the Bahamas. Types unknown and this confirmed from personal enquiries to NHM, London. Included by Michaelsen (1910: 50) as a *D. japonica* subspecies, it is now held in *D. barwelli* synonymy]

Drawida japonica: Michaelsen 1900: 115.; 1910: 48.; Stephenson 1922: 119, figs. 1-6.; Chen 1933: 189, fig.?: Gates 1935: 3 (questioning Chen’s ‘*D. japonica*’); Chen 1936: 291 (syn. *grahami*).; Kobayashi 1937, 1938: 94, fig. 1.; Gates 1939: 411 (cf. *grahami*).; Kobayashi 1940: 263 (part. + *propatula*).; 1941: 458, 515.; Chen 1959: 15, fig. 22.; Ohfuchi 1965: 546 (plus fig. apparently copied from Chen).; Easton, 1981: 37 (part. excluding *grahami* and with China not included in distribution range).; Blakemore 2003; 2005/2007 (syn. *grahami* from China).

Drawida japonica typica: Michaelsen 1910: 49.; 1927: 85.; Stephenson 1917: 366, fig. 1.; 1922: 126.; 1923: 142, fig. 52 (part. syn. *bahamensis* and explaining Michaelsen’s initial incomplete description).

Drawida japonicus typicus: Michaelsen 1931: 7.

Drawida japonicus: Michaelsen 1931: 523 (part. syn. *siemsseni*).

Drawida grahami Gates 1935: 3.; 1939: 408. [From Suifu, Szechuan. Type(s) USNM: 20093. Said to have more ventral spermathecal pores in mid-bc otherwise cf. *D. japonica*; three gizzards in 12-14 (as in three of Gates’ five subsequent *D. japonica* specimens); one of seven of Gates’ specimens lacked markings].

Drawida propatula Gates 1935: 449. [From China. Types USNM 20179. Said by Kobayashi (1938: 94, 1940: 263) to be similar although Kobayashi (1940: 265) maintained them separately mainly on extent of the ovisacs]. **Syn. nov.**

Drawida japonica japonica: Blakemore 2005/2007 (syn. *grahami*); 2008; Blakemore *et al.* 2010: 1.

Material examined. Berlin Kat. Nr. 2122 (*Drawida japonica* Syntype! Japan. Hilgendorf) a dissected specimen 26mm long with the last 24 of its 95 segments regenerated that, although the internal organs are mostly removed, is nevertheless in good condition; Hamburg #403 syntype label states collected by Hilgendorf in Japan but is only a desiccated posterior portion (ca. 8mm and 25 segments comprising mostly intestinal soil and possibly Michaelsen’s ‘25 segmenten regeneriert Hinterende’- RJB pers. obs. IV.2010). Five specimens, two from “*Aichi*” [kanji for the prefecture] (one with dorsal pores and GMs and one

without either) plus three from fields at Nagurashi near Nagoya, Aichi-ken (one with dorsal pores but no GMs, the other two without either) all stored in Hachioji collection (RJB inspected 20.IX.2002); Watarase one specimen without dorsal pores but with GMs in 9lhs posteriorly and 10rhs anteriorly, and male pores in 10/11 on eversible penes with gizzards in 12-14 (coll. IV.2003 by Dr Takafumi Kamitani of YNU and RJB inspected 9.IV.2004); one specimen collected from Kamakura Daibutsu shrine 13.VI. 2004 by RJB (identified tentatively); four specimens from rice fields in Hikone-shi, Shiga-ken (collected 19.VI.2009 by RJB) – one dissected and figured (Fig. 3.5) plus donor for mtDNA COI sample (GenBank GQ-500902); plus three others, all lacking dorsal pores but having GMs as detailed below (these latter specimens’ reg.no.s LBM 1380000085 ex FY2009-13-3).

Original author’s description [Michaelsen (1900: 115)]: “*1. D. japonica* (Michlsn.) 1892 *Moniligaster japonicus*, Michaelsen in: Arch. Naturg., v. 581 p. 232. Grau. Kopflappen klein. Borsten eng gepaart, in ventralen und lateralen Paaren; Borstendistanz aa gleich bc. Vor den männlichen Poren am 10. Segm. je 1 Pubertätsgrube. 2 große kugelige Muskelmagen im 12. und 13. Segm. Testikelblasen kugelig; Samenleiter eng gewunden; Prostataen dick schlauchförmig. Ovarien im 11. Eiersäcke dick schlauchförmig, unregelmäßig verdickt und gekrümmmt, vom Dissep. 11/12 bis etwa in das 16 Segm. reichend. L. 28, D. 3mm; Segmz. 95 (Hinterende regeneriert). Japan”.

[Translation: Gray. Prostomium small. Setae tightly coupled in ventral and lateral pairs; setal distance *aa* equal to *bc*. Before each male pore on 10 is a puberty pit (= genital papillae). Two large spherical gizzards in 12 and 13. Testes sacs spherical bubbles; vas deferens tightly wound; prostates thickly tubular. Ovaries in 11; ovisacs thickly tubular, irregularly thickened and curved; reaching from 11/12 to around 16. Length 28; width 3 mm; segments 95 (posterior regenerated). Japan.]

External characters. (from synonymy above and pers. obs.): Grey when preserved (Michael

sen, Stephenson and pers. obs. Aichi or, Hikone specimens) or ruddy in field and pale bleached in alcohol. Size ~26–130 mm by 2–4.5 mm although Chen (1933: 194, 1959: 15) says up to 200 mm in specimens that Gates (1935: 4) doubted were conspecific. Segments up to 142 [cf. 126–179 Kobayashi 1938, 1940 (for *D. propatula*); 195, Chen]. Prostomium small and seen with a characteristic ventral cleft in Aichi and Biwa specimens (pers. obs.). Dorsal pores intermittently present (RJB pers. obs. in syntype #2122 where they are small in 8/9 and 10/11 and gaping in 31/32 and irregularly to 58/59; also in some Aichi specimens where they were in 9/10 seen due to ejecta although possibly small in 8/9 too, thereafter intermittent and, although gaping when present, they cease before segment 45) or, more usually, absent. Setae small and closely paired (aa = bc). Nephropores seen in anterior in d lines or above in 3–8, thereafter in cd or c or ab lines on each side from 9; less obvious in posterior. Clitellum 9,10–13,½14. Spermathecal pores 7/8 in bc (but closer to c). Male pore superficial lateral of b on porophore on 10 [according to Stephenson (1923) and Gates (1935)] or in 10/11 [Michaelsen (1892: 232; 1900: 115) who says they are clearly in 10/11 and overhanging segment 11 after a pair (or unilateral) markings in 10, this repeated by Gates, 1939] current specimens have male pores on those protruded ‘flaps’ overhanging 10/11 and just lateral to b lines (pers. obs. as per Michaelsen and Kobayashi) or (doubtfully) as evversible penes in the Watarase specimen]; Hikone specimens have ventral region of segments 10 and 11 flared around the male pores to present a flattened area; ‘Genital Markings’ variously in 7–13 [e.g. Michaelsen has them in 10, Stephenson in 7–9 and 12, Easton in 7–9 and 12–13, Chen in 7–12, and Kobayashi in 7–13 and, for *grahami* and *calebi* they are stated to be in 7–13 thus this is accepted as the extent]; that said, however, it is possible they are all just parasitic artefacts (RJB pers. obs.) – and sometimes they are absent [e.g., Gates, Kobayashi (1938) and RJB pers. obs. of Aichi specimens; cf. *D. barwelli*]. Female pores minute in 11/12 near b lines.

Internal anatomy. Septa 5/6–8/9 thickened; septum 10/11 weak and displaced to enclose ovaries and egg-sacs in 11. Large tendons pass on

either side from dorsum at 10/11 to the ab ventrally in 11 which may assist bowing of the male pores during copulation. Hearts 6–9. Nephridia holoic and vesiculate (always?). Spermathecae with ampulla from septum 7/8, mostly pear-shaped or spherical but sometimes with elongate extension to duct that is convoluted to small atrium. Testis sacs spherical, bulging from 9/10, vasa deferentia tightly wound. Prostates described by Michaelsen (1900: 114) as thickly tubular and by Gates (1939: 410, 412) as round, sessile discs (*grahami*) or club-shaped and erect (*japonica*); here described as ‘blunt’. Ovaries in 11 with long ovi-sacs from 11/12 as far back as 16 [or 43 according to Gates (1935: 3) who, rather condescendingly, said that “*These appendices were overlooked by both Michaelsen and Stephenson*” but he failed to account that extent is dependent on stage of maturity]. Gizzards usually two in 12–13 (Michaelsen, Stephenson and pers. obs.) or there may be three in 11–13 (Stephenson) or 12–14 (Chen, Kobayashi and seen in Watarase and Hikone specimens) or in some of 11,12–13,14 (Gates cf. *D. barwelli*); intestinal origin in 15–18 after gizzards. Corresponding to the external ‘markings’ are small, white spherical bodies that are buried in body wall and appear to duct to exterior – however, these may be parasitic artefacts of gregarine sporozoites (pers. obs. and see Blakemore 2008).

Species associations. Michaelsen (1892) recorded these taxa at the same time as *Drawida japonica* (No. 2122. Hilgendorf rp.): *Eisenia fetida* (Japan; o. 2121, Hilgendorf); *Aporrectodea trapezoides* (Japan; No. 2119, Hilgendorf); *Eisenia japonica* (Japan, Enosima; No. 2117, - Hilgendorf rp. 29, III, 1875); *Duplodicordilus schmardae* (Japan; No. 2120. Hilgendorf rp.), *Metaphire sieboldi* (Japan; No. 2133. Langegg rp., Hilgendorf leg.), and *Metaphire hilgendorfi* [Japan, Hakodate; No. 2123, Hilgendorf rp. (Typische Exempl. α und Exempl. γ und δ); Japan, No. 2144, Hilgendorf rp. (Exempl. ε); Japan, Yokohama; No. 2149, v. Martens rp. (Exempl. β)] plus *Amynthas corticis* [as *Perichaeta indica* Horst. (Japan; No. 2188. Hilgendorf. rp.) and as *Perichaeta divergens* (Japan; No. 2116. Hilgendorf rp.)]. Which, if any, of these were co-incident is unknown.

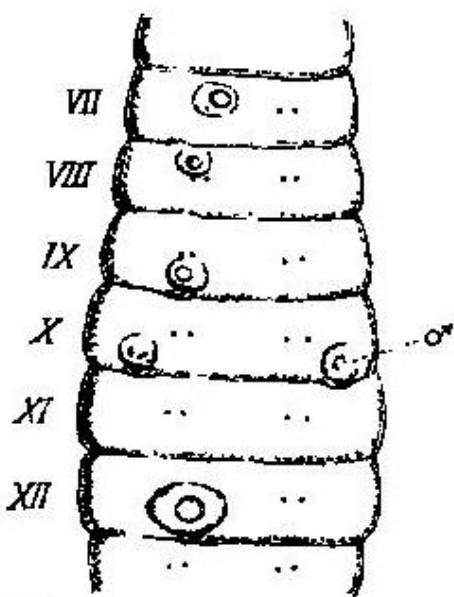


Figure 3.1. *Drawida japonica* from Stephenson (1923: fig. 52 seemingly mislabeling 'marking' on 10 as male pore)

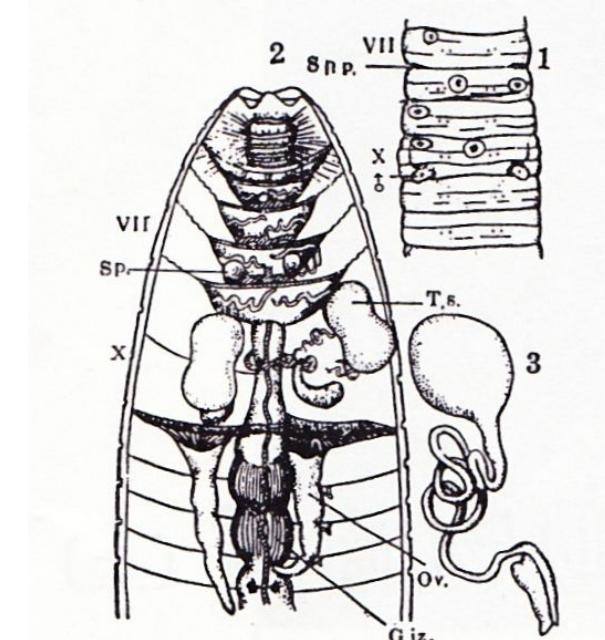


Figure 3.3. from Ohfuchi (1965?: #1 external, #2 internal, #3 a spermatheca; note: Ohfuchi's #2 has miscounted the internal segments – a quite common mistake – cf. Chen's original)

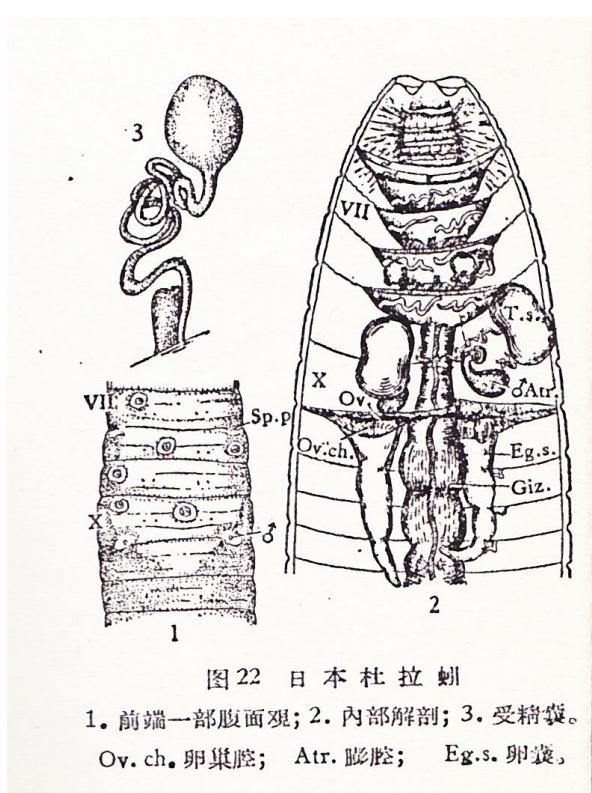


Figure 3.2. From Chen (1959?: fig. 22)

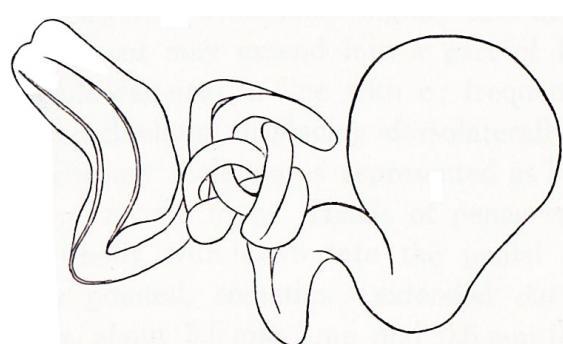


Figure 3.4. from Kobayashi (1938: fig. 1 of a spermatheca being exactly similar to current sketch)

Distribution. Japan, from around Tokyo, Honshu to Nagasaki, Kyushu, *Drawida japonica* is probably not wholly endemic to Japan as its distribution includes southern China, Taiwan, the Ryukyu Islands, Japan (Honshu, Shikoku, Kyushu), Korea (including Quelpart/Jeju-do), and south-east Asia. Inclusion of *D. propatula* adds central and northeast China. Stephenson (1923: 143), Gates (1939: 413 six specimens from Mur-

ree) and Paliwal & Julka (2005) list it outside the normal *Drawida* domain from the western Himalayas, India; and it is reported (as “*Drawida japonica* Michaelsen 1917”) from the famous Punjab beer-district of Solan, Himachal Pradesh (Dhiman & Battish 2005). [Note: Stephenson’s (1923) description included *bahamensis* that is now included in *barwelli* as it typically lacks ‘genital markings’; cf. Japanese *D. eda* specimens lacking markings that have a male pore on extractible penis rather than external and ‘flap-like’].

Ecological and Economic Importance. Apart from contributing to soil fertility and a basis for food-webs – as with all other earthworms – this species has been utilized as a bioindicator for soils in China (Fang *et al.* 1999), assuming their identification is correct.

Remarks. In summary, the problem of integrity of *Drawida japonica* is that it was soon confused with *D. bahamensis* and this possibly introduced new characteristics into the definition. Subsequently, *D. bahamensis* was either included in *D. japonica* or transferred as a junior synonym of *D. barwelli*. Perhaps this is indicative of entities such as *D. bahamensis* being intermediate between these two earlier described taxa, thereby eroding validity of either. Moreover, the only substantial characters differentiating *D. japonica* from prior *D. barwelli* are the flap-like male poropores (cf. Watarase specimens) and possibly its cleft prostomium. Markings vary and, on current interpretation so far, may actually be parasitic artefacts. Whether these are truly characteristic of *D. japonica* is currently uncertain. Kobayashi (1938: 94) remarked how similar Chinese *D. propatula* Gates, 1935 is, but the latter is supposedly larger and has longer egg-sacs although these features are not now of much significance, thus it is placed in synonymy.

Michaelsen (1910: 48–52; 1931: 523) recorded subspecies for this taxon, *Drawida japonica siemsseni* (Michaelsen 1910) from Fuchow, China that Michaelsen (1931b: 7) later said “seems somewhat questionable” and which Gates (1939: 414) redescribed from the Hamburg type [labeled

as “V 6333 *Drawida japonicus* Mich. f. *siemsseni*. Tiensin, Futschau” that he said was inadequate as the internal organs had been removed in course of the original dissection and lost, and for which there is also a discrepancy as Reynolds & Cook (1976: 170) list type as “6233”] as a clearly separate species having 6 gizzards (cf. Gates 1935: 3); and *Drawida japonica bahamensis* (Beddard, 1893), for which types are listed as missing in Reynolds & Cook (1976: 75), and that was subsequently placed, at least by Easton (1984: 112) and Blakemore (2002, 2008), in synonymy of *Drawida barwelli* (Beddard, 1886).

Other similar species are *Drawida minuta* (Bourne, 1887) with male and spermathcal pores in *ab*, and *Drawida willsi* Michaelsen, 1907 that differs, at least, by being a bluish grey or reddish grey colour and it may have an additional pair of rudimentary male pores in 9/10 corresponding to those in 10/11, as is more usual. A specimen of ‘*D. willsi*’ that Michaelsen (1907 or 1909?) described from Western Himalayas, was thought by Stephenson (1923) to be *D. japonica*.

Kobayashi (1940b) had proposed a dispersal of *D. japonica* from China to Japan, possibly via Taiwan and questioned the identification of some earlier records from outside the Japan/Korea area. Although, Gates (1972: 244) was of the opinion that this species came originally from the Indian Himalayas, from whence it was recorded by Stephenson (1923), and from Yunnan and Szechuan, Stephenson (1923: 143) had earlier said its occurrence at Murree and probably Simla (by Michaelsen 1909) in the western Himalayas was “far from the proper *Drawida* region”. This domain he regarded as in southern India and the eastern Himalayas and so Stephenson classed *D. japonica* as “a wanderer [i.e., a peregrine] of a pronounced type”. Easton (1981: 37) included only Japanese and Korean records in his distribution range for this taxon.

Identification now confirmed and augmented from inspection of original syntypes and new material. Major differences from some earlier accounts (in synonymy above) are that markings

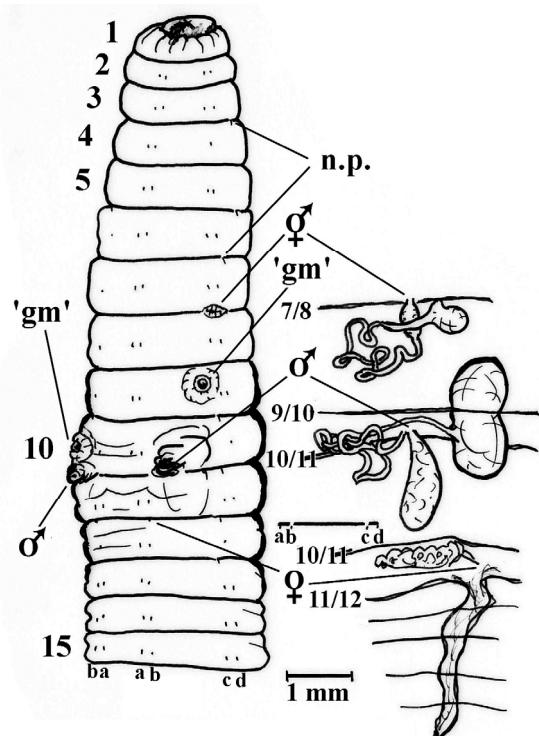


Figure 3.5. Shiga specimen (LBM1380000085 that provided DNA sample for Genbank)

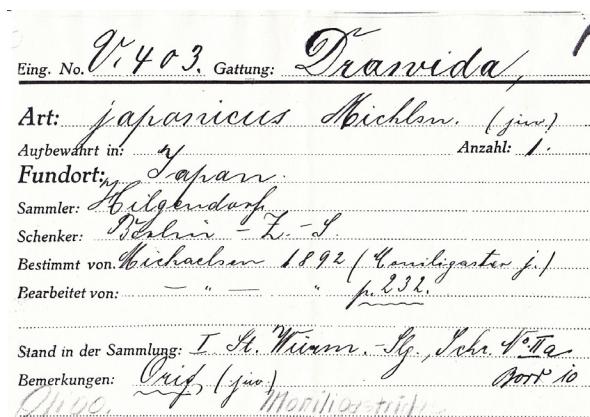


Figure 3.6. Copy of the label for Hamburg Syntype #403.

may be present only in 10 (just ventral of c) as per Michaelsen's original account *or absent*; Stephenson (1923: 142) has them in "vii–ix and xii" and Kobayashi (1938: 95) from "about a thousand specimens from about a hundred localities" allows either in 7–13 *or totally absent*, while Easton gives them in 7–9, 12 and 13 [actually Easton (1981) states "vii–ix, occ. xii & xiii" which may

be a mistake for "vii–xi, occ. xii & xiii", or not] and, for *D. grahami* synonym, Gates (1939) has them in 7–13 *or absent* in at least one of his Suifu specimens. Present specimens either lack them entirely or have them unilaterally or paired on posterior or anterior of some of 7–9 and anteriorly in 10 or 13. It appears Stephenson (1923: 142, fig. 52 – herein Fig. 3.1) mistook the paired genital markings posteriorly in 10 for male pores that he himself (p 124) describes as intersegmental in 10/11. Moreover, in the present specimens, dorsal pores may be absent or intermittent: e.g., the Berlin syntype and one Aichi specimen had them from 8/9/10 but thereafter, although gaping, they became intermittent and were not present after segment 60. Earlier authors overlooked the intermittent and variable dorsal pores.

As remarked by Blakemore *et al.* (2010), recent inclusion in COI barcode analyses (by Huang *et al.* 2007 and Chang *et al.* 2008) from Chinese source material differed by ~17% from a Lake Biwa sample and conspecificity of these Chinese

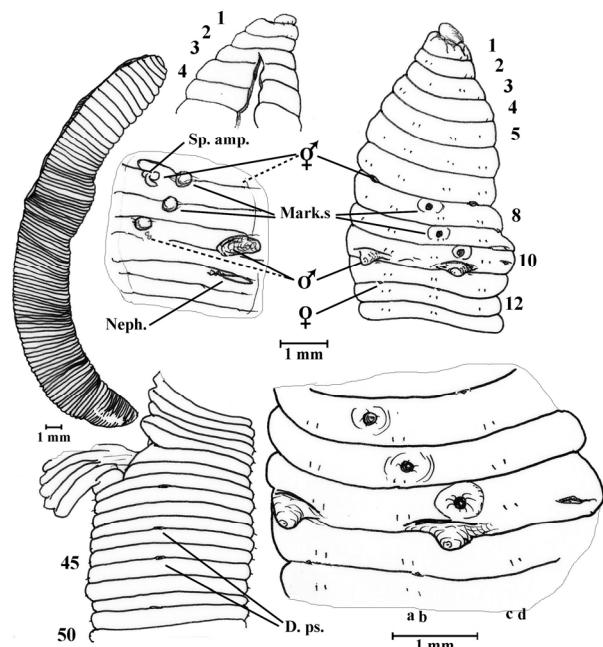


Figure 3.7. Sketch of Berlin Syntype #2122 showing habitus at low scale; anterior, externally and internally (with remnant lhs ampulla, rhs prostate and vesiculate nephridium in 12), and mid-body showing dorsal pores; plus an enlargement of genital field

specimens, at least, require comparison with synonymous *Drawida grahami* Gates, 1935 types (Smithsonian #20093), also with types of erstwhile sub-species *Moniligaster bahamensis* Beddard, 1893 and *Drawida japonica siemsseni* (Michaelsen, 1910) (Hamburg #6233), plus its likely new synonym, Chinese *D. propatula* Gates, 1935.

Drawida nepalensis (Michaelsen, 1907) with gizzards in 13–20 and *D. ramdadana* (Michaelsen, 1907) are also closely reminiscent taxa. It may be noted that *D. gracilis*, *rangoonensis*, and *rara* by Gates, 1925, and *D. flexa* Gates, 1929 plus similar taxa from Myanmar appear to differ only in their two to five gizzards in 12–23 – see Gates (1962: 320–351). Another potential synonym is *D. vulgaris* Gates, 1930, unless it is a synonym of *D. bullata* Gates, 1933: 424 (with its synonym *D. fucosa* Gates, 1933: 439) – see Gates (1962: 313).

DISCUSSION

Regarding *Drawida* nomenclature, two substitute names for Chinese *Drawida* seem to have been omitted in a recent website (i.e., insects.tamu.edu/research/collection/hallan/test/Annelida/Family/Moniligasteridae.txt accessed 13.III.2010). As a reminder, the new replacement names were: *Drawida zhangetalia* Blakemore, 2006 for *Drawida cheni* Zhang *et al.*, 2006 (non *Drawida cheni* Gates, 1935), and *Drawida zhongi* Blakemore, 2006 for *Drawida sulcata* Zhong, 1986: 28 (non *Drawida sulcata* Michaelsen, 1907: 144 from South India), published under provisions of ICZN (1999: Art. 8) for permanently invalid primary homonyms, and both new names formed with approval of their original authorities. The same website has further catalogued several other invalid names making them searchable on the Net and giving the false impression they are valid taxa. Whereas Oishi (1932: 18) listed as new several Japanese species names, viz.: “*Drawida toriui*” sometimes misspelt “*Drawida torini*”, “*Drawida kamakuraensis*”, “*Drawida tosaensis*”, “*Drawida hataii*” sometimes misspelt “*Drawida hatai*”, and “*Drawida kambarai*”, none of these was supported by description and all are therefore

nomina nuda outside of ICZN nomenclature (Easton, 1981). Current earthworm species from mainland China are checklisted by Blakemore (2007 - <http://bio-eco.eis.ynu.ac.jp/eng/database/earthworm/China.pdf>); and similar checklists are freely provided for India, Taiwan, Korea, Japan and all SE Asia faunas as hosted on the same YNU server site and mirrored on <http://www.annelida.net/earthworm/> (accessed 10. V. 2010)

Taxonomically key characteristics are often ambiguous for small *Drawida* species. Moreover, size range and colouration are generally variable in most earthworms. As the moniligastrid clitellum is only one-cell thick (i.e., ‘exquisiticlitellate’ rather than ‘crassiclitellate’ as with other megadriles) its extent is often incalculable and, because its nutritive function is replaced by copious yolk (i.e., macrolecithal) eggs, the ovisacs can be either highly gravid and extensive, or evacuated and flimsy. Thus morphology is especially variable naturally due to the state of maturity and reproductive activity of the specimen. Moreover, diagnostic intestinal gizzards frequently vary intraspecifically in both exact number and in relative position (or on an author’s determination of muscularity). First and second segments are weakly divided externally in some species confounding counts as does convergence of weak internal septa. Septa are increasingly displaced around the ovaries which themselves are translocated two segment to 11 rather than occurring in 13 as is usual for other megadriles (thereby rather obviously accounting for the reduction of moniligastrid ancestral male segments in anteriorly in 10 and 11 to a pair of ‘intrasepal’ testis sacs now observable in 9/10). In many earlier diagnoses “atrium” refers to the spermathecal opening but it may equally apply to the male chamber. Hence diagnoses of species are particularly reliant upon the skill of the original author and, from the classical texts of Michaelsen (1900) and Stephenson (1930) onwards, confusion has tended to be compounded. New consideration of possible parasitic origin of definitive ‘genital markings’ is an additional complication (see Blakemore *et al.*, 2010).

Table 1. Variations in genital markings (GM) & dorsal pores (DP) in *D. japonica*

Contingencies Found	GM Present (but variable)	GM Absent
DP Present (intermittent)	Yes	No
DP Absent	No	Yes

Table 2. Characters of *D. japonica* found in Japan, cf. *D. barwelli*

Character/ <i>Drawida</i> cf. spp.	<i>barwelli</i> summary as here	<i>japonica</i> summary as here	<i>japonica</i> Aichi spec A	<i>japonica</i> Aichi spex B	<i>japonica</i> Biwa spex	<i>japonica</i> Watarase spec
Colour	pale/unpig.	grey/pale	?	?	pink/pale	?
Size (mm)	30-65	28-130	50	30-40	50-70	55
GMs	None	7-13 or none	9 & 10	None	8-10	9 & 10
Dorsal pores	Yes/No	Yes/No	No	Yes/No	No	No
Form of MP	penis in pouch	flap or mound	flap or mound	?	flap or mound	penis in pouch
Gizzards	2-4	2-3	2	2	3	3
Gizzard Segs.	12,13- 14,15,(16)	(11,)12-13,14	12-13	12-13	12-14	12-14

Spec. – specimen; Spex. – specimens; Segs. – segments.

Table 3. Key characters of prioritized *Drawida* listed in Japan modified from Easton (1981: tab. 1) cf. *D. barwelli* ‘proper’

<i>Drawida</i> spp. / Character	<i>barwelli</i> (Beddard, 1886)	<i>japonica</i> (Michaelsen, 1892)	<i>nemora</i> Kobay., 1936	<i>koreana</i> Kobay., 1938	<i>keikiensis</i> Kobay., 1938	<i>ofunato- ensis*</i> O., 1938	<i>taira- ensis</i> O., 1938	<i>morioka- ensis</i> O., 1938
Colour	pale/unpig- mented	grey/pale	dark blue	dark blue	yellow/ grey	dark yellow	flesh red	dark lead grey
Size (mm)	30-65	28-130(200)	65-185	63-100	40-54	228-283	59-92	65-100
GMs	None	7-13 I	6-13 (I)	7-12 I	None	7-13	8 I	None
DPs	Yes/No	Yes/No	No	No	No	No	?	?
Gland in 7	No	No	Yes	No	Yes	No	Yes	No
Form of Male Pores	penis in pouch	flap or porophore	penis in pouch	flap or porophore	penis in pouch	penis in pouch	penis in pouch	penis in pouch
Gizzards	2-4	2-3	3-5	2-3	3-4	4+ (?)	4	2-3
Gizzard Segs.	12,13- 14,15,(16)	(11,)12- 13,14	12,13- 15,16	12-13,14	12,13-15	12-15,16?	13-16?	10,11-12

Kobay. – Kobayashi; O. – Ohfuchi; GM – genital marks; I – irregular ‘markings’ that may be absent or artefactual. **Bold** options distinguish taxa. ? – data not provided, ambiguous/inconsistent by original author or from Easton’s table.*Misspelt “onfunatoensis” by Easton (1981: 35). [Note: *D. hattamimizu* as dealt with by Blakemore et al. 2010].

If the supposedly distinguishing but uneven ‘genital markings’ of *D. japonica* eventually prove to be parasitic artefacts, as they appear at least in the Japanese material with the disc-like markings internally resembling spherical *Monocystis* cysts (RJB, pers. obs.), then *D. japonica* confusion in the past with prior *D. barwelli* seems possible, although the flap-like male pores now serve to separate it. Further testing of *Drawida* relationships without consideration of the *D. barwelli* (Beddard, 1896) type-species’s types (in London, BMNH:1904:10:5:522-3, 582? - cf.

“(BMNH: 1904:10.5.2-3)” Easton 1984: 112), and those of its ten synonyms, is pending.

Arguments against the ‘markings’ being parasitic are that externally they look like typical sucker-like discs and they only appear in the anterior region where GMs usually occur. Arguments for them being parasitic in origin are their internal resemblance to *Monocystis* gregarine sporozoite cysts, their unevenness, and that by occurring just where worms attach when breeding they may infect new hosts whilst in

intimate contact. Moreover, they are absent and therefore ‘un-necessary’ in some specimens. In the case of some *Drawida* specimens having ventral parasites, these may be likened to a venereal ‘kissing-disease’. It is easy to envisage how the setae of copulating individuals may pierce the cuticle of their partner thus facilitating exchange and entry of sporozoite infective agents, and the locations would be exactly where the ‘genital markings’ are found in specimens of *Drawida japonica* – in or adjacent to setal lines in the anterior segments which closely attach during copulation.

Drawida gisti gisti Michaelsen, 1931 (from China and Korea), *D. nemora* Kobayashi, 1936 (from Korea, Japan and China), *D. koreana* Kobayashi, 1938 (from Korea and China), Japanese *D. tairaensis* Ohfuchi, 1938, Chinese *D. jeholensis* Kobayashi, 1940 and Indian *D. calebi* Gates, 1945 all have the same irregularity of markings (when present!) that may also be parasitic artefacts as for *D. japonica*; species that are sympatric are distinguished in Table 3.

If the parasitic artefact theory (Blakemore in Blakemore *et al.*, 2010) is correct, then species separated only on the strength of their (irregular) ‘genital markings’ may require wider re-assessment. For example, Indian *Drawida pomella* Gates, 1934: 250 may re-join *D. papillifer* Stephenson, 1917: 370 in synonymy of *D. hodgarti* Stephenson, 1917: 366; and *D. gisti* Michaelsen, 1931 may also require re-evaluation along with its subspecies *D. g. nanchangiana* Chen, 1933: 200 and *D. g. anchiniana* Chen, 1933: 202 (cf. Gates, 1935: 2; 1939: 408) and cf. *D. calebi* Gates, 1945. *Drawida gisti* as redescribed by Gates (1935: 2, 1939: 406), Kobayashi (1938) and Chen (1959: 16) from China and Korea was said to have an “urn-shaped” gland within the atrial wall of each spermatheca, irregular ‘genital markings’ (sometimes absent, e.g. Kobayashi 1938, 1940), small penes, and gizzards in 12–14 only. It is almost identically with *D. calebi* Gates, 1945: 211 from Jubbulpore and widely spread in Central India with types listed as missing in Reynolds & Cook (1976) but which is probably a new synonym of *D. gisti* Michaelsen,

1931, and both are now comparable to prior *D. hehoensis* Stephenson, 1924.

The parasitic theory of ‘genital markings’ as newly extended in *Drawida* species may at least partly account for differences in pheretimoid *Amyntas songnisanensis* Hong & Lee, 2001: 284 and its likely synonym *A. multimaculatus* Hong & Lee, 2001: 288 from Korea (that both may be synonyms of some other taxon lacking such artifacts). A similar parasitic cause probably also explains the irregular spots dorsally on *Archipheretima ophiodes* Michaelsen, 1929 and similarly on *Archipheretima middletoni* James, 2009 from the Philippines. In fact it is quite usual to see abundant sporozoan *Monocystis* parasites through the body walls of certain specimens and for these to mistakenly be give taxonomic significance, e.g., those reported for *Amyntas maculosus* (Hatai 1930) (RJB pers. obs.). As with some other invertebrates, a species may yet have its own unique host-specific complement of parasitic species that often bear the host’s name.

Key characters of current and available Japanese *Drawida* species are given in Table 3. From this character data it appears that:

- *D. japonica* differs from *D. barwelli* mostly in the form of the male pores
- *D. koreana* differs from *D. japonica* mostly in its blue colour
- *D. keikiensis* differs from *D. barwelli* by its glands in 7
- *D. moriakaensis* differs from *D. japonica* mostly in the form of the male pores

The newly described species from Lake Biwa, *D. eda* Blakemore, differs by having eversible male pores on penes, five gizzards in 13–17, in lacking both pigment and genital markings, and in having an accessory genital gland near spermathecal atria internally in 7. The same sort of gland is also reported for *D. nemora*, *D. keikiensis*, *D. tairaensis* and *D. jeholensis*. Chinese *Drawida jeholensis* Kobayashi, 1940 is unpigmented, has irregular markings in 7–11, male pores on poropore ‘flaps’ overhanging 10/11, and two or three gizzards in 11,12–13. Thus, the only major difference of *D. jeholensis* from prior *D. japonica* is (consistent?)

presence of this accessory gland in 7 near its spermathecal atrium.

Atrial structure of poorly-known *Drawida jal-paigurensis* Stephenson, 1916: 306, which is otherwise quite similar to *D. japonica*, appears to be substantially different to the accessory gland arrangement noted herein (see Stephenson, 1923: 141, fig. 51)

DNA barcoding, such as using a fragment of mtDNA COI marker gene, ideally from primary types (Blakemore *et al.* 2010), offers a possible solution to taxonomic confusion within *Drawida* in Asia and further abroad, as has been initially attempted herein.

An ancillary considerations in this, the first of a short series of pragmatic works on earthworms from the Kinki region of central Japan, is the “*Clarity of vision and courage of purpose*” (Wheeler 2004) needed from individual taxonomists and natural history museums to bring about the (r)evolution of taxonomy into the Bio-Info-Tech Age (see Blakemore 2000, 2007, 2008, Blakemore *et al.* 2010), especially in this UNO-designated International Year of Biodiversity.

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Appendix

Preliminary mtDNA COI sequences for *Drawida eda* Holotype cf. BLAST comparisons

LK 186-187 W4 (*D. eda* Holotype) CO1 (small letters = single strands, caps = double strands):-

atCataagatatttgaacaCTATATTATTGGGTGTCTGGCAGGCATAGTTGGAGCCGGCATAGGATATTAAATTCGTA TTGAGCTTAGGCAACCCGGCACATTGGAAAGAGATCAACTATACAACACTATTGTAAC TGCGCATGCTTTATTAA TAATTCTTTAGTGATGCCTGTGTTATTGGGGTTTGGAAATTGGTTGCTACCTCTGATGCTGGAGCACCAAG ATATAGCTTTCCCCGTTAAATAATTAAAGATTGATTACTTCTCCGGCCCTTATTATTAGTTCTGCTATA GTAGAAAAGGGGGCAGGCAGTGGTGAAGTGTATCCTCCCTAGCTAGTAATATGGCTCACGAGGTCTGTG TGACTTAGCTATTTCCTTGATTTAGCGGGTGCATCTCCATTCTAGGATCATTAAATTCTTACCAACCGTTATT AATATGCGATGAGTTGGAATGAATATGGAGCGCGTCCCATTATTGTATGAGGGGTTAATTACTGTAATTCTTTA TTACTATCTTACCGTACTAGCGGGTGAATCACTATGCTTTAACAGATCGGAACCTAAACTCATTTTCGAT CCTCGAGGAGGAGGTGATCCAATTATCAGCACTTATTGATTTGGTCACCCGAGTTAA

Current GenBank BLAST scores for *Drawida eda* preliminary COI data (% congruence similarity)

EF077597.1 *Drawida japonica japonica* voucher 06-270 Identities = 512/641 (79%)

GQ500902.1 *Drawida japonica* voucher LBM128000000 Identities = 485/614 (78%)

GQ500900.1 *D. hattamimizu* voucher LBM1380000082 Identities = 487/633 (76%)